



Fire Fighter Suffers Sudden Cardiac Death at His Fire Station – Georgia

SUMMARY

On June 17, 2004, a 47-year-old male career fire fighter (FF) performed his normal duties. Because no emergency calls came in during the shift, the day was spent in training on policy issues. At approximately 1900 hours, a crew member thought the FF was asleep in a chair in the fire station's bedroom. Upon closer observation, the crew member noticed that the FF's chest was not rising for falling. The FF was unresponsive with no pulse and no respirations. An automated external defibrillator (AED) was applied, cardiopulmonary resuscitation (CPR) was begun, and an ambulance was requested. After approximately 35 minutes of CPR and advanced life support (ALS) administered on the scene, in the ambulance, and at the hospital, the FF was pronounced dead at 1948 hours. The death certificate completed by the county coroner, listed "cardiac dysrhythmia" as the immediate cause of death due to "massive cardiomegaly" due to "hypertensive heart disease." The autopsy conducted by a medical examiner of the Georgia Bureau of Investigation, Division of Forensic Sciences, reported "cardiac dysrhythmia secondary to a massively enlarged heart" that "was the consequence of hypertensive heart disease" as the cause of death.

NIOSH investigators offer the following recommendations to prevent similar incidents or to address general safety and health issues:

- *Conduct periodic medical evaluations to determine a fire fighter's medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.*

- *Consider conducting exercise stress test (EST) for male fire fighters over the age of 45 years with two or more factors for coronary artery disease (CAD).*
- *Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of fire fighting.*
- *Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.*
- *Designate an employee to administer the pre-placement and annual medical evaluations and their outcomes.*
- *Perform an annual physical performance (physical ability) evaluation.*
- *Provide fire fighters with medical evaluations and clearance to wear self-contained breathing apparatus (SCBA).*

The **Fire Fighter Fatality Investigation and Prevention Program** is conducted by the National Institute for Occupational Safety and Health (NIOSH). The purpose of the program is to determine factors that cause or contribute to fire fighter deaths suffered in the line of duty. Identification of causal and contributing factors enable researchers and safety specialists to develop strategies for preventing future similar incidents. The program does not seek to determine fault or place blame on fire departments or individual fire fighters. To request additional copies of this report (specify the case number shown in the shield above), other fatality investigation reports, or further information, visit the Program Website at www.cdc.gov/niosh/firehome.html or call toll free 1-800-35-NIOSH



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INTRODUCTION & METHODS

On June 17, 2004, a 47-year-old male FF suffered cardiac dysrhythmia and was found pulseless and apneic shortly after 1900 hours while on duty at his fire station. Despite ALS treatment at the scene, en route, and at the hospital, the FF was pronounced dead at the hospital's Emergency Department (ED) at 1948 hours. On September 7, 2004, NIOSH contacted the affected Fire Department (FD) to gather more information on the fatality. On September 27, 2004, an occupational physician from the NIOSH Fire Fighter Fatality Investigation Team traveled to Georgia to conduct an on-site investigation of the incident.

During the investigation NIOSH personnel met and/or interviewed the following people:

- Fire Chief
- Chief of Training and Training Officer
- FF's crew members
- FF's wife
- FD contract health care provider
- FF's private physician

During the site visit NIOSH personnel reviewed the following documents:

- FD training records
- Death certificate
- FD incident report
- Ambulance and emergency medical services report
- Hospital ED report
- Medical records
- FD physical examination protocols
- FD policies and operating guidelines
- FD run reports for August 31, 2003 to August 31, 2004

On October 20, 2004, the autopsy report was received from the Georgia Bureau of Investigation, Division of Forensic Sciences, and reviewed.

INVESTIGATIVE RESULTS

Incident. On June 17, 2004, a 47-year-old male career fire fighter returned to duty after 2 days off. On June 17 the FF performed his normal duties. No emergency calls came in that day, and the day was spent attending a classroom training session on policy issues. The FF was wearing his turnout jacket, but not the rest of his turnout gear or his SCBA. According to crew members, the FF was seated during this training and was not physically active.

At no time during his shift, or during the days or weeks prior, did the FF report to crew members any symptoms suggestive of cardiac problems (e.g., chest pain, shortness of breath, dizziness, palpitations, syncope, etc.). In fact, several crew members noted that he appeared healthy and physically fit. From 1996 to 2002, he jogged on shift. According to crew members the fire fighter smoked one to one and a half packs of cigarettes per day, and was diagnosed with high blood pressure (hypertension) but was non-compliant with his anti-hypertensive medication.

At approximately 1900 hours, a crew member walked into the fire station's bedroom and observed the FF apparently asleep in a chair against the wall. The crew member went to his locker and came back into the bedroom. The crew member was standing next to his bed and noticed that the FF's chest was not rising or falling. At that time the crew member



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called out the FF's name several times but received no response. The crew member checked the FF's pulse and realized that he was pulseless and apneic. The crew member ran downstairs and alerted the crew of the situation. They immediately took the external defibrillator, the medical jump bag, and the oxygen bottle from one of the fire apparatus upstairs. The AED was applied, he was placed on a backboard, and CPR was begun.

An ambulance was requested and emergency medical services (EMS) arrived at 1933 hours. Reevaluation by the EMS paramedics found the FF to be lying supine on the floor, cool to the touch, pulseless, and apneic, with CPR being performed. Down time was unknown. The EMS paramedics connected the FF to a cardiac monitor, which found the FF in asystole (no heart beat) confirmed by two leads of the monitor. CPR was continued and the EMS paramedics inserted a breathing tube into the FF's airway (intubation) and placed an intravenous (IV) line into a vein. Correct breathing tube placement was confirmed by breath sounds in both lungs, but not a secondary (technological) test as recommended by the American Heart Association.¹ The FF was loaded into the ambulance and departed the scene at 1930 hours. The FF was given ALS medications at the scene and en route, but the cardiac monitor showed no change from asystole. During the transport to the hospital ED, the EMS paramedics continued CPR.

The ambulance arrived at the hospital's ED at 1936 hours and the EMS paramedics turned over the FF's care to the ED physician and code team. On admission to the hospital, the ED staff checked for proper breathing tube, IV line, and cardiac lead placement and continued CPR. The FF was unresponsive and had no pulse and no spontaneous respirations. He had no blood pres-

sure and his pupils were fixed and dilated. The cardiac monitor in the ED indicated pulseless electrical activity (PEA) (no heart beat). The advanced cardiac life support (ACLS) protocol was followed for PEA for approximately 10 minutes and ACLS medications and CPR were given without success. Asystole (no heart beat) was again confirmed by two leads of the cardiac monitor. At 1948 hours the fire fighter was pronounced dead by the ED physician and resuscitation attempts were discontinued. The ED physician diagnosed "cardiac arrest." The FF received approximately 35 minutes of CPR and ALS administered on the scene, in the ambulance, and at the hospital before being pronounced dead.

Medical Findings. The death certificate, completed by the chief deputy coroner, listed "cardiac dysrhythmia" as the immediate cause of death due to "massive cardiomegaly" due to "hypertensive heart disease." The autopsy conducted by a medical examiner of the Georgia Bureau of Investigation, Division of Forensic Sciences, reported "cardiac dysrhythmia secondary to a massively enlarged heart" that "was the consequence of hypertensive heart disease" as the cause of death. The autopsy report also noted "moderate arterionephrosclerosis" and "mild to moderate atherosclerotic coronary artery heart disease." Significant findings from the autopsy are as follows:

- Hypertensive heart disease
 - Severely enlarged heart (cardiomegaly) weighing 840 grams (normal < 400 grams), which is in the 95th percentile for body weight
 - Markedly severely thickened left wall of the heart (concentric hypertrophy of the left ventricle)



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- Moderate hardening of the kidney due to high blood pressure in the small arteries of the kidneys (arterionephrosclerosis)
- Mild to moderate heart disease (atherosclerotic plaque blockage of three coronary arteries)
 - Approximately 40%–50% blockages (stenosis) in each of the left anterior descending, circumflex, and right coronary arteries.
- Mild thickening (myocytic hypertrophy) and mild to moderate scarring of the heart muscle (interstitial fibrosis), but no evidence of heart attack (acute or remote infarct)
- Microscopic examination of the kidney showed kidney cancer (papillary renal cell carcinoma)

His blood carboxyhemoglobin level (a test of carbon monoxide exposure) was not checked due to no exposure to fire smoke during his shift. No drug screen was performed.

Although the FF had no known history of CAD, the FF did have risk factors for CAD: male gender, age over 45, hypertension, tobacco use, and physical inactivity. Records from his personal physician's office showed that in 1997 his resting EKG was consistent with significant left ventricular hypertrophy (LVH), and in 1998 his resting EKG was interpreted as abnormal with borderline LVH and muted T waves in limb leads II and III. A laboratory report dated 1997 from his personal physician's office showed a total cholesterol level of 202 milligrams per deciliter (mg/dL) with the reference range showing borderline: 200–240 mg/dL and desirable: less than 200 mg/dL. LDL cholesterol, HDL cholesterol, and cholesterol/HDL ratio were not found for

NIOSH review. No exercise stress test report was available for NIOSH review. There was no family history of heart attack.

At autopsy, the FF weighed 194 pounds and measured 72 inches tall giving a body mass index of 26.3 kilograms/meter² (kg/m²), indicating that he was overweight (normal body mass index is < 25 kg/m²).² He performed no recent physical exercise activity on a regular basis. He smoked approximately one pack of cigarettes per day for more than 10 years. Medical records indicate a ten year history of hypertension. His personal physician recommended treatment for hypertension, but the FF was not always compliant. Records from his personal physician's office showed a range of blood pressures from 120/80 millimeters of mercury (mmHg) to 234/126 mmHg with the majority of readings indicating Stage 2 hypertension (systolic greater than or equal to 160 mmHg or diastolic greater than or equal to 100 mmHg).³ The last clinical note in the medical records of the FF's personal physician (May 19, 2003) indicated his blood pressure was 122/76 mmHg that day.

DESCRIPTION OF THE FIRE DEPARTMENT

At the time of the FF's death, the FD consisted of six career fire fighters staffing one of the 19 fire stations serving approximately 200,000 residents. The primary responsibilities of the FD included emergency incidents and response to community mutual aid calls for support of structure fires. From August 1, 2003 to August 31, 2004, the FD responded to 3,617 incidents. The FF responded to 37 incidents from August 1, 2003 until his death on June 17, 2004.



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Fire fighters are City employees. The FF had returned to work for his first shift after his regular 2 days off. The fire fighter had 22 years of experience as a fire fighter. He was certified as a Georgia Certified Fire Fighter and a First Responder.

Pre-placement Evaluations. All probationary employees are required to undergo a pre-placement medical evaluation conducted by a contractor hired by the City. The City specifies the components of the medical evaluation, which includes the following:

- Complete medical history and questionnaire
- Height, weight, and vital signs
- Physical examination
- Vision test
- Audiogram
- Urinalysis
- Heavy metal test (24-hour urine)
- Blood tests: Complete blood count, chemistry panel (SMA 6) that includes a serum glucose measurement, and lipid profile
- Spirometry (lung function tests)
- Chest X-ray (one view - PA)
- Resting electrocardiogram (EKG)

This information is provided to the Fire Chief. A candidate physical ability test (PAT) is required, but candidates do not receive medical clearance prior to the test, nor do they receive medical clearance to wear a SCBA. Qualitative respirator fit testing is currently performed by the FD. Hepatitis B vaccination and skin testing for tuberculosis (PPD) are currently offered by the FD.

Periodic Evaluations. The FD does not require a periodic medical evaluation/clearance for all fire fighters; however, the FD does require a periodic medical evaluation/clearance for the Hazardous Materials (HAZMAT) Team. The components of this HAZMAT evaluation are the same as the pre-placement evaluation. The FD does not require a periodic PAT. FFs are encouraged to receive a complete physical examination at their own expense. FFs injured on duty must be cleared for return to work by their personal physician.

Fitness/Wellness Programs. There is no mandatory fitness program. The FD has a voluntary fitness program through the YMCA, Health Central, Omni Fitness, Gold's Gym, and Power South free of charge if the fire fighter uses the facilities at least 15 times per month, otherwise, a prorated discount is based on frequency of use. Some fire stations have exercise (strength and aerobic) equipment owned by the employees. The FD provides programs for health maintenance including smoking cessation, weight control, high blood pressure, diabetes, and cholesterol.

DISCUSSION

Sudden cardiac death (SCD) is often the first sign of coronary heart disease (CHD). In the United States, up to 80% of SCDs are due to coronary atherosclerosis (plaque). The cardiomyopathies (dilated and hypertrophic) account for another 10%–15% of SCDs. Risk factors for SCD include age, male gender, heredity (including race), cigarette smoking, high blood cholesterol, high blood pressure, diabetes, LVH, nonspecific electrocardiographic abnormalities, and markers of inflammation (C-reactive protein).⁴ The FF had six of these risk factors.



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High blood pressure requires the heart to work harder to pump the blood. At first, the heart muscle compensates for this increased workload by concentric LVH (increase in wall thickness). Ultimately, the heart weakens and becomes dilated, and heart failure appears.⁵ Transient ischemia (lack of oxygen) in the previously scarred or hypertrophied (enlarged) heart has been suggested as one of the mechanisms that causes the heart to become electrically unstable. This may result in a potentially fatal dysrhythmia.^{4,6} The EKG may show changes of LVH, but the EKG underestimates the frequency of cardiac hypertrophy compared with that shown by echocardiogram. Most deaths due to high blood pressure result from heart attack or congestive heart failure.⁵

In this case, the FF had a history of high blood pressure and LVH on EKG. In addition, the autopsy found a severely enlarged heart with markedly severely thickened left heart wall (concentric LVH). Both of these factors, the severity of the enlargement and the pattern of hypertrophy (concentric), are negative prognostic factors for cardiac mortality.^{7,8}

To reduce the risk of heart attacks, sudden cardiac death and other medical conditions among fire fighters, the NFPA has developed the NFPA 1582 guideline entitled *Comprehensive Occupational Medicine Program for Fire Departments*.⁹ NFPA 1582 recommends a thorough medical examination for all FD members. This standard recommends screening for obstructive CAD by an exercise stress test (EST) for fire fighters with two or more risk factors for CAD (family history of premature [less than age 60] cardiac event, hypertension, diabetes mellitus, hypercholesterolemia [total cholesterol greater than 240 mg/dL or HDL cholesterol less than 35 mg/dL], and cigarette

smoking).⁹ These recommendations are similar to those of the American College of Cardiology/American Heart Association (ACC/AHA).¹⁰

The FF in this case had two of these CAD risk factors. Had the FD been following NFPA 1582, the FF would have been sent for an EST. The EST may have identified ventricular arrhythmias associated with LVH, identified the severity of his underlying LVH, or noted some reduced exercise capacity due to his massive LVH. NFPA 1582 considers cardiac hypertrophy (e.g. LVH) a condition associated with sudden incapacitation and therefore compromises their ability to perform essential job tasks safely. In addition, NFPA 1582 considers any reduction in left ventricular function (a reduced left ventricular ejection fraction) to compromise a FF's ability to perform essential job tasks safely. Had this FF been put on restricted duty until his heart condition was further evaluated and/or treated, perhaps he would not have died at this time.

RECOMMENDATIONS

NIOSH investigators offer the following recommendations to prevent similar incidents or to address general safety and health issues:

Recommendation #1: Conduct periodic medical evaluations to determine fire fighter medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.

The purpose of periodic medical evaluations is to ensure that fire fighters have the ability to perform duties without presenting a significant risk to the safety and health of themselves or others. Guidance regarding the content and scheduling of periodic medical examinations for fire fighters



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can be found in NFPA 1582, 2003 edition.⁹ In addition, NFPA 1582 also provides guidance on medical requirements for persons performing fire fighting tasks.

Applying NFPA 1582 involves legal and economic issues, so it should be carried out in a **confidential, nondiscriminatory** manner. Annex B of NFPA 1582 provides guidance for Fire Department administrators regarding legal considerations in applying the standard. The economic concerns go beyond the costs of administering the medical program; they involve the personal and economic costs of dealing with the medical evaluation results. NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, addresses these issues in Chapter 8-7.1 and 8-7.2.¹¹ The success of medical programs hinges on protecting the affected fire fighter. The department must (1) keep the medical records confidential, (2) provide alternate duty positions for fire fighters in rehabilitation programs, and (3) provide permanent alternate duty positions or other supportive and/or compensated alternatives if the fire fighter is not medically qualified to return to active fire fighting duties.

Recommendation #2: Consider conducting exercise stress test (EST) for male fire fighters over the age of 45 years with two or more factors for coronary artery disease (CAD).

NFPA 1582 and the IAFF/IAFC *Wellness/Fitness Initiative* both recommend EST for some fire fighters to screen for obstructive CAD.^{9,12} NFPA 1582 recommends EST for those fire fighters with two or more CAD risk factors. According to NFPA 1582, these CAD risk factors are:

- family history of premature (less than age 60) cardiac event
- hypertension

- diabetes mellitus
- hypercholesterolemia (total cholesterol greater than 240 mg/dL or HDL cholesterol less than 35 mg/dL)
- cigarette smoking⁹

These recommendations are similar to those of the ACC/AHA.¹⁰

The EST could be conducted by the fire fighter's personal physician or the FD's contract physician. If the fire fighter's personal physician or the contracted physician conducts the test, the results must be communicated to the FD physician, who should be responsible for decisions regarding medical clearance for fire fighting duties.

Recommendation #3: Ensure that fire fighters are cleared for duty by a physician knowledgeable about the physical demands of fire fighting.

Physicians providing input regarding medical clearance for fire fighting duties should be knowledgeable about the physical demands of fire fighting and familiar with the NFPA 1582 consensus guidelines. To ensure physicians are aware of these guidelines, we recommend that the FD provide the contract and private physicians with a copy of NFPA 1582. In addition, we recommend the Fire Department carefully consider the opinion of the employee's private physician regarding return to work. This decision requires knowledge not only of the employee's medical condition but also of the employee's job duties. Frequently, private physicians are not familiar with an employee's job duties or with guidance documents such as NFPA 1582. Lastly, we recommend that a FD contracted physician review all return-to-work clearances. Thus, the final decision regarding medical clearance for return to work lies with the FD with input from many sources including the employee's private physician.



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Recommendation #4: Phase in a mandatory wellness/fitness program for fire fighters to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.

Physical inactivity is the most prevalent modifiable risk factor for CAD in the United States. Additionally, physical inactivity, or lack of exercise, is associated with other risk factors, namely obesity and diabetes.¹³ NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, and NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Fighters* require a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being.^{11,14} In 1997, the International Association of Fire Fighters (IAFF) and the International Association of Fire Chiefs (IAFC) published a comprehensive Fire Service Joint Labor Management *Wellness/Fitness Initiative* to improve fire fighter quality of life and maintain physical and mental capabilities of fire fighters. Ten fire departments across the United States joined this effort to pool information about their physical fitness programs and to create a practical fire service program. They produced a manual and a video detailing elements of such a program.¹² The FD should review these materials to identify applicable elements. Other large-city negotiated programs can also be reviewed as potential models.

Recommendation #5: Designate an employee to administer the pre-placement and annual medical evaluations and their outcomes.

This employee should maintain the confidentiality of the medical records. If this employee is a member of the FD and participating in the Department's annual medical evaluation, a

policy should prevent the employee from self-administering the program.

Recommendation #6: Perform an annual physical performance (physical ability) evaluation.

NFPA 1500 requires fire department members who engage in emergency operations to be annually evaluated and certified by the FD as meeting the physical performance requirements identified in paragraph 8-2.1.¹¹ This finding did not contribute to this FF's death, but was identified during the NIOSH investigation.

Recommendation #7: Provide fire fighters with medical evaluations and clearance to wear SCBA.

OSHA's Revised Respiratory Protection Standard requires employers to provide medical evaluations and clearance for employees who use respiratory protection.¹⁵ These clearance evaluations are required for private industry employees and public employees in states operating OSHA-approved state plans. Georgia is not a state-plan state; therefore, public sector employers are not required to comply with OSHA standards. Nonetheless, we recommend voluntary compliance with the Respiratory Protection Standard.

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